Telcordia (formerly Bell Communications Research, Inc.)

# Digital Video Networking Services

*In the mid-1990s, worldwide telecommunications capacity was expanding and broadening. Companies in a variety of industries began to develop ways to take advantage of this expanded capacity. One of the emerging fields was digital video, which offered the advantages of television for real-time visual monitoring, along with the flexibility and speed of computing. Designers envisioned a broad range of applications, including virtual meetings and conferences, entertainment, education, telemedicine, and even home shopping. However, there was one obstacle: each application might have its own protocols and could malfunction on different hardware or software platforms.*

*Bell Communications Research, Inc. (Bellcore) planned to develop the knowledge base, expertise, and tools to overcome this limitation. Bellcore had shaped standards for other cyber technology and was active in industry-led forums on digital video and interoperability. After the company's management indicated that it would fund part of the high-risk research, a Bellcore team applied for and received a cost-shared award under the Advanced Technology Program's (ATP) 1995 "Digital Video over Information Networks" focused program. The two-year project began in 1995.*

*By the end of the ATP-funded project, the company had developed a prototype implementation of digital video protocols and had transferred it to the product development side of the company. It had also filed a patent for a router adapted for digital video delivery. However, this technology did not prove economically viable in the United States, because the components upon which it was built were new and expensive. Proponents of using existing Internet protocols as a means of delivering video prevailed, even though picture quality was limited.*

*By 1998, industry forums on digital standards no longer convened. In the next several years, Bellcore's technology was superseded by technologies from Asia, which today have the lead in digital video. Despite the failure of Bellcore's product and services, its successor company, Telcordia, retains staff expertise and is working with telecommunications companies to develop products and services as the U.S. market for digital video grows rapidly.*

**COMPOSITE PERFORMANCE SCORE**
(based on a four star rating)

No Stars

**Research and data for Status Report 95-04-0029 were collected during March – May 2005.**

## Networks Spur Drive for Compatibility

In the mid-1990s, computer users anticipated the much-heralded information superhighway, a seamless flow of data through a network or networks of computers. Companies were developing hardware and software to make existing networks faster and more far-reaching in their ability to load content. One of the emerging technologies was digital video, whose applications ranged from video conferencing to home shopping to entertainment, such as pay-per-view movies, sporting events, and concerts.

An easy-to-use and economical network that accommodated video transmission was of great interest to video content providers, network service providers, network and end-system suppliers, and end users. But none of these stakeholders had the expertise or the means to resolve the issues that impeded interoperability (that is, the ability of different programs to read and write the same file formats and use the same protocols). Bell Communications Research, Inc. (Bellcore), which had been created by the break-up of the Bell telephone system to continue research into communications technology, had the expertise as well as the personnel and facilities to attempt such a resolution. Bellcore provided research, development, and standards for the seven regional holding companies of the Bell telephone companies. The telephone companies had the infrastructure to deliver video on demand. Bellcore wanted to use this infrastructure to its maximum advantage.

To promote interoperability, the telecommunications industry was pursuing technical solutions and standards. Bellcore had been instrumental in formulating standards for other technologies; key among them were the synchronous data transmission on optical media, asynchronous transfer mode, and the digital subscriber line. Bellcore took part in industry forums that were promoting open standards, such as the Asynchronous Transfer Mode (ATM) Forum and the Digital Audio-Visual Council (DAVIC). ATM is a way by which audio, visual, and computer data can be sent simultaneously over a high-speed digital line. DAVIC was promoting the Digital Storage Media-Command and Control (DSM-CC) toolkit, which prescribed protocols for the delivery of multimedia broadband services for the International Organization for Standardization (ISO). DAVIC, the Digital Video Broadcasting consortium, the ATM Forum, Audiovisual Multimedia Services, and the Foundation for Intelligent Physical Agents used at least part of DSM-CC, and the Advanced Television Systems Committee was expected to adopt it as well.

In 1994, Bellcore applied for and received a two-year award from ATP, through the “Digital Video over Information Networks” focused program, to develop technologies that would enable the interoperable use of competing digital video standards. In its application, Bellcore said its project would accelerate industry efforts to deploy digital video, foster the growth of the information services industry, create new businesses and industries, and “bring the digital information age into being.” Bellcore would make available to the industry the results of its research in the form of testing and consulting services and through the licensing of software tools designed to achieve interoperability. Bellcore was not able to commit the resources required to pursue the broad scope of its proposed project, but was eager to share costs to accelerate the research and development.

### Bellcore Envisions Experimental Technologies

Bellcore wanted to foster interoperable digital video technologies and stimulate the growth of video on demand. It planned to create the knowledge base, expertise, and tools required to enable interoperability among video applications. Its research would be in three related areas:

- Experimental software technologies that would enable different applications, network architectures, and data to work together
- Other experimental software technologies that would resolve and integrate conflicting control and signaling protocols
- Experimental technologies that would analyze the effects of ATM switching and routing of video over networks with different operating systems and protocols

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“The expertise and tools we develop will enable low-cost, universal access to a video-rich information infrastructure that supports a wealth of video applications,” Bellcore wrote in its proposal. The tools would reduce the risk of market fragmentation and costly investment in systems that could not work with other systems.

With many companies vying to develop products that would implement the still-evolving digital technology, speed-to-market was also important. Bellcore estimated that ATP funding would shorten the time-to-market by one to two years and predicted that it would be selling its products within one year after the project ended.

Bellcore expected to produce the following:

- Test tools that the company would license for use in analyzing interoperability and monitoring network performance
- Testing services that would help suppliers and users determine the interoperability of their digital video products and would help them develop new applications
- Consulting services to analyze digital video equipment design, before it is commercialized, to enable interoperability with existing products
- Network operations systems software to enable registration, initialization, and downloads for a range of applications and services
- Reference implementation (described below) for video portions of the DSM-CC protocol for licensing to industry

A reference (or sample) implementation is a working example of a standard that shows how to implement the standard. Developed concurrently with product specifications and tests, a reference implementation verifies that the specification can be implemented. The reference implementation enables validation of conformance tests, serves as the standard against which other implementations can be measured, and clarifies the intent of the specification where conformance tests are inadequate.

To pursue a prototype that supported digital video and complied with DSM-CC, a company would have to either build or buy a reference implementation. Bellcore wanted to develop the reference implementation for the digital standards because “these standards were going to be the Holy Writ for the industry,” said David Waring, the Bellcore team leader.

## Bellcore Develops Reference Implementation

In the first year of the project, Bellcore built and demonstrated a reference, or prototypical, implementation based on two parts of DSM-CC, the user-to-user standard and the user-to-network standard. These two standards were designed to control video reception by clarifying aspects of broadband service delivery and by establishing protocols for features normally found on videocassette recorders, such as fast-forward, rewind, and pause, for all services delivered to the home. With protocols, information appliances, such as a cable box, could access a variety of services from a range of service providers. The content could be video, audio, Internet web pages, interactive games, or as-yet-undeveloped possibilities. DSM-CC could work with packet networks and with Internet protocols and could be used in computers in video delivery, audio delivery, and with interactive content such as computer games.

***Bellcore wanted to foster interoperable digital video technologies and stimulate the growth of video on demand.***

In the second year of the project, Bellcore experimented with a fiber-based wide area network (WAN) and ran digital video experiments on such issues as delay, packet loss, and buffering. Bellcore undertook these experiments as part of a broad effort to move the industry toward digital video without expecting to see a direct commercial application. “This was the ‘R’ of R & D,” said Waring.

At the same time, Bellcore released a “beta” version of the reference implementation, and the research team transferred the technology to the product development side of the company. The company readied its reference implementation for market, and even though the standards were still evolving, they planned to build in tracking of the standards’ development as part of the product. They began marketing the reference implementation through trade shows, sent out an initial mailing, and prepared a more extensive package in response to expressions of interest.

## Lack of Scalability Dooms Technology

Bellcore expected that equipment manufacturers, primarily those who made set-top boxes (which controlled transmission and sat on top of the television), would be its primary market, but national and international telephone and cable carriers showed interest as well. The company received drafts of contracts from two companies. However, when the ATP-funded project ended, the company reported that technical and economic barriers were significant. The supporting technologies, such as streaming video, set-top boxes, encoding and decoding, and DSL (Digital Subscriber Line), were new and expensive. Software developers were using the new and expensive redundant array of independent disks (RAID) technology, which made digital software more fault-tolerant but added to its cost. Major telecommunications companies such as Verizon and British Telecom delivered their technology to 3,000 sample households, but could not cost-effectively scale it up to serve markets of 10,000 households or more.

## Industry Abandons Standards

In addition, the industry wavered on what approach to take to distribute digital video. During the ATP-funded project, the majority of the standards community thought DSM-CC was the paradigm. The minority thought that the Internet was the model to follow. The discussion among the standards forums became increasingly contentious as proponents of these two viewpoints debated the best way to deploy digital video technology.

"During 1997, major shifts in the industry have potentially lessened the impact of the DAVIC DSM-CC approach for interactive digital video. The Internet, with its underlying IP protocol, is being advocated by some as a complete alternative to DSM-CC. This is now a major topic of debate and discussion, and already a softening of interest in DSM-CC has been observed," the company wrote in its final report to ATP. Support for the DSM-CC standard waned, so that two years after the end of the ATP-funded project, DSM-CC was effectively defunct. "Our potential customers were watching the standards debate, and decided to wait a while," said Waring.

As a result, Bellcore had no market for its reference implementation and its planned consulting services. The company never sold a reference implementation. Further, with the DSM-CC standards gone, it was not clear what would replace them. The code developed under ATP funding has no value today, because software technology has superseded Bellcore's implementation.

Shortly after the ATP-funded project ended in 1997, Science Applications International Corporation acquired Bellcore and changed its name to Telcordia, with the mission of providing operations and support systems and intelligent network systems to telecommunications operators. Although Telcordia retained the digital video knowledge it gained during the project, video on demand in the United States stalled for nearly a decade. At the time, Southeast Asia, and Europe to a lesser degree, began to dominate digital video technology.

The significant barrier in the United States was the last-mile problem, or the lack of broadband to the home market. In July 1998, industry observer Robert Cringely wrote, "Four years ago, several big phone companies were threatening to enter the video-on-demand business … [but] it's a business that ultimately didn't happen because of that old time-and-money multiplier: It cost 10 times more than the phone companies thought it would to actually send an old movie to your house over the phone line. Blockbuster Video was still cheaper."

Although the technology never found a market, Waring says the project was worthwhile. Through ATP's digital video focused program, Bellcore participated in workshops and shared its research experiences with five other ATP awardees. Without ATP funding, Bellcore would not have undertaken this project and would not have developed that knowledge, according to Waring. The award meant that Bellcore could perform a new service and add to its core competency in digital video interoperability services, Waring said. In addition, it holds a patent on a router developed during the project.

Bellcore had been responsible for synchronous data transmission on optical media (Sonet) and ATM standards and had shaped the DSL standards. "We attempted to do that for digital video and failed," Waring said. "Betting on standards is risky business."

Since 2003, telecommunication industry leaders have been taking a second look at digital video, now called Internet protocol television (IPTV). Telcordia is working with SBC Communications and Verizon to deliver a video-on-demand service. Waring sits on an IPTV task force, with plans to sell Telcordia's future products to Verizon, BellSouth, and other companies. Cable and telecommunications companies are vying for "triple-play" contracts to provide bundled telephone, television, and high-speed Internet service to households.

## Conclusion

The drive for a national information infrastructure was proceeding quickly in the 1990s; every few months, more bandwidth was added, which allowed more features to be added as well. Bell Communications Research (Bellcore) was actively shaping the standards for compatibility on computer networks. The company saw the need for a model that demonstrated the digital video transmission standard and that provided a method to test components' compatibility. To do this, Bellcore needed to develop the knowledge base, tools, and services quickly, but was unable to obtain full funding from internal sources. Bellcore applied for and received a cost-shared ATP award under the "Digital Video over Information Networks" focused program to proceed with its development.

During the project, Bellcore developed a prototypical demonstration, or reference implementation, of digital video based on Digital Storage Media-Command and Control (DSM-CC) standards. However, digital video on demand did not prove to be economically viable at that time. Although it could be delivered to small markets, scaling up to larger markets was too expensive, primarily because the technologies needed to support digital video were themselves new and expensive. In addition, the standards debate stalled as members of forums concerned with defining the standard failed to agree on the best way to deploy the technology. The Internet's promise of being better able to deliver video in a cost-effective format that satisfied consumers' demands also stalled Bellcore's technology. Ultimately, work on the DSM-CC standard was abandoned, with the result that Bellcore's reference implementation never sold. The company obtained a patent for a router, published an article, and made a presentation on the ATP-funded technology.

Since 2003, prospects for digital video in the United States have revived. Telcordia, the successor to Bellcore, has expertise in digital video technology and is pursuing relationships with companies to develop digital video on demand. Although the technology developed under the ATP-funded project is obsolete, Telcordia expects to be part of the re-emerging industry.

# PROJECT HIGHLIGHTS
## Telcordia (formerly Bell Communications Research, Inc.)

**Project Title:** Digital Video Networking Services (Interoperability Tools for Digital Video Systems)

**Project:** To develop the knowledge base, expertise, and cross-industry tools to enable interoperability of digital video systems.

**Duration:** 11/1/1995 - 12/21/1997
**ATP Number:** 95-04-0029

**Funding** (in thousands):**

| | | |
|---|---|---|
| ATP Final Cost | $1,091 | 97.2% |
| Participant Final Cost | 31 | 2.8% |
| Total | $1,122 | |

**Accomplishments:** With ATP funding, Bell Communications Research, Inc. (Bellcore) accomplished the following:

- Developed a reference implementation software for digital video over networks

Received the following patent for technologies related to the ATP-funded project:

- "XDSL-based internet access router" (No. 6,493,348: filed December 2, 1998; granted December 10, 2002)

**Commercialization Status:** Bellcore's proposed technology was based on the assumption that a vibrant market for digital video products and services would develop and that an international interoperability standard would be agreed upon. When the market for digital video emerged, standards other than Bellcore's interoperability standard were adopted. Therefore, the product that emerged from this project, a reference implementation for the standard, was never sold.

**Outlook:** The outlook for this technology is weak, because there is no longer a need for the technology. Although there is renewed interest in digital video, other technologies have superseded the technology developed by Bellcore.

**Composite Performance Score:** No Stars

**Focused Program:** Digital Video over Information Networks, 1995

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**Publication:**

- "Himonas, S.D., and A.D. Gelman. "A Digital Storage Media-Command and Control Network." GLOBECOM 1997, *Proceedings of the Global Telecommunications Conference 1997*. Piscataway, NJ, IEEE: 766-770, 1997.

**Presentation:**

- National Association of Broadcasters' Trade Show, Las Vegas, 1997.

** As of December 9, 1997, large single applicant firms are required to pay 60% of all ATP project costs. Prior to this date, single applicant firms, regardless of size, were required to pay indirect costs.